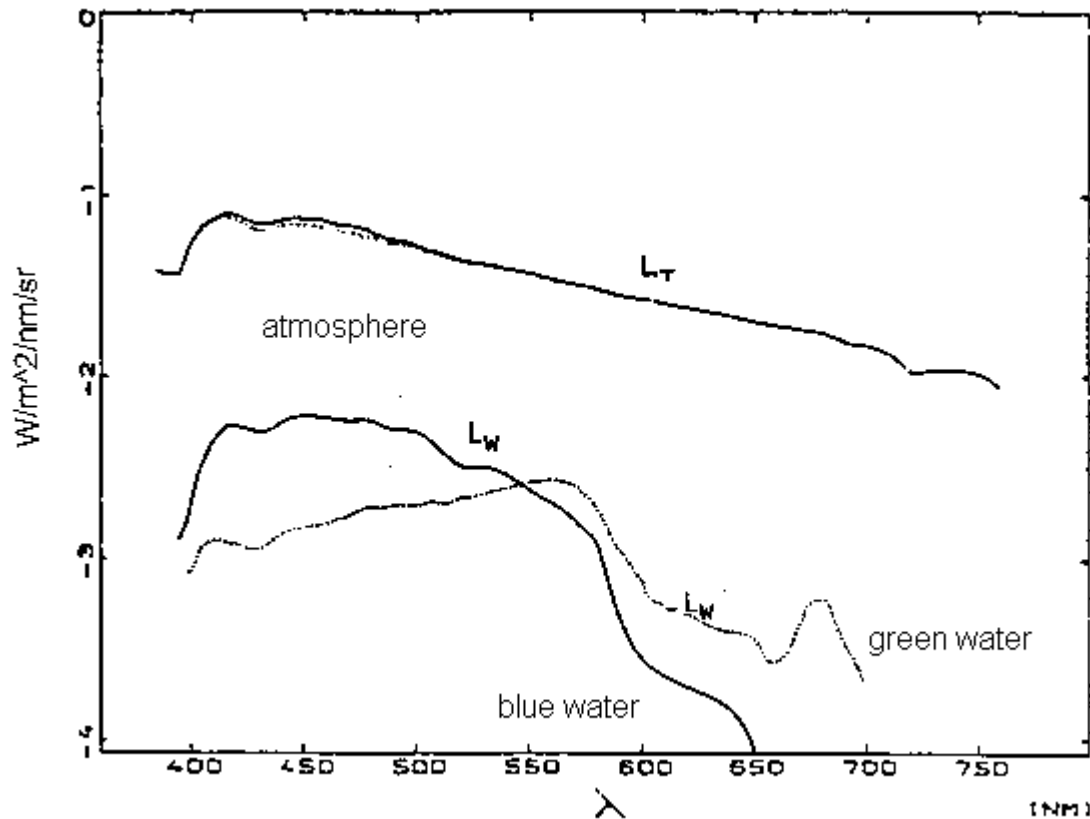# SeaWiFS Atmospheric Correction

Bryan Franz

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We want to measure the "color" of the ocean, but we actually measure ocean + atmosphere. The atmosphere is 90% of the signal, and it must be accurately modeled and removed.

Effects of the Atmosphere

- Gaseous absorption (ozone, water vapor, oxygen).

- Molecular scattering (air molecules), also referred to as Rayleigh scattering. Scattering efficiency decreases with wavelength as λ^{-4}. Reason for blue skies and red sunsets.

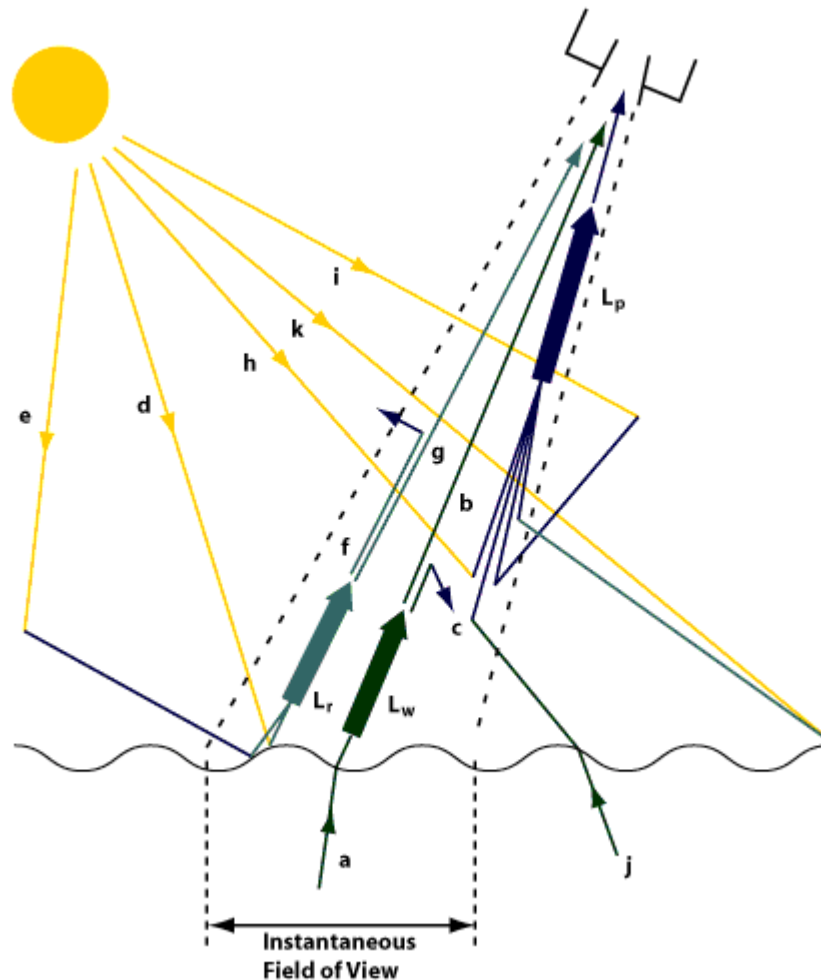- Aerosol scattering and absorption (haze, dust, pollution). Whitens or yellows the sky.

Gaseous Absorption

Transparency Windows

Transmittance due to O2 and Water-Vapor
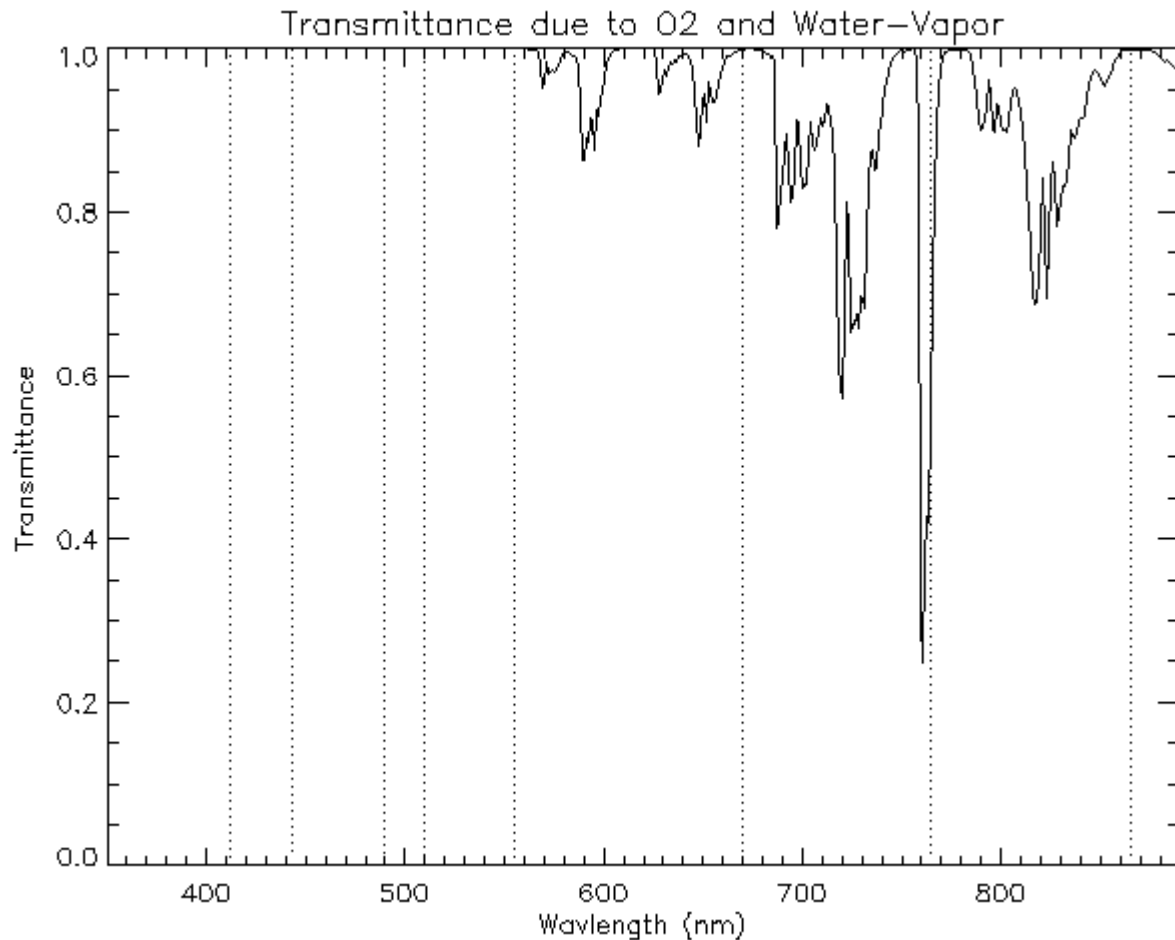
Light Paths to the Sensor
Scattering and Attenuation

Atmospheric Correction Equation

$$L_t = L_r + (L_a + L_{ra}) + tL_{wc} + TL_g + t\,L_w$$

- L_w is the quantity we wish to retrieve at each wavelength.
- TL_g is Sun glint, the direct reflectance of the solar radiance from the sea surface. This effect is avoided through tilting.
- tL_{wc} is the contribution due to "white"-capping, estimated from statistical relationship with wind speed.
- L_r is the contribution due to molecular (Rayleigh) scattering, which can be accurately computed.
- $L_a + L_{ra}$ is the contribution due to aerosol and Rayleigh-aerosol scattering, estimated in NIR from measured radiances and extrapolated to visible using aerosol models.
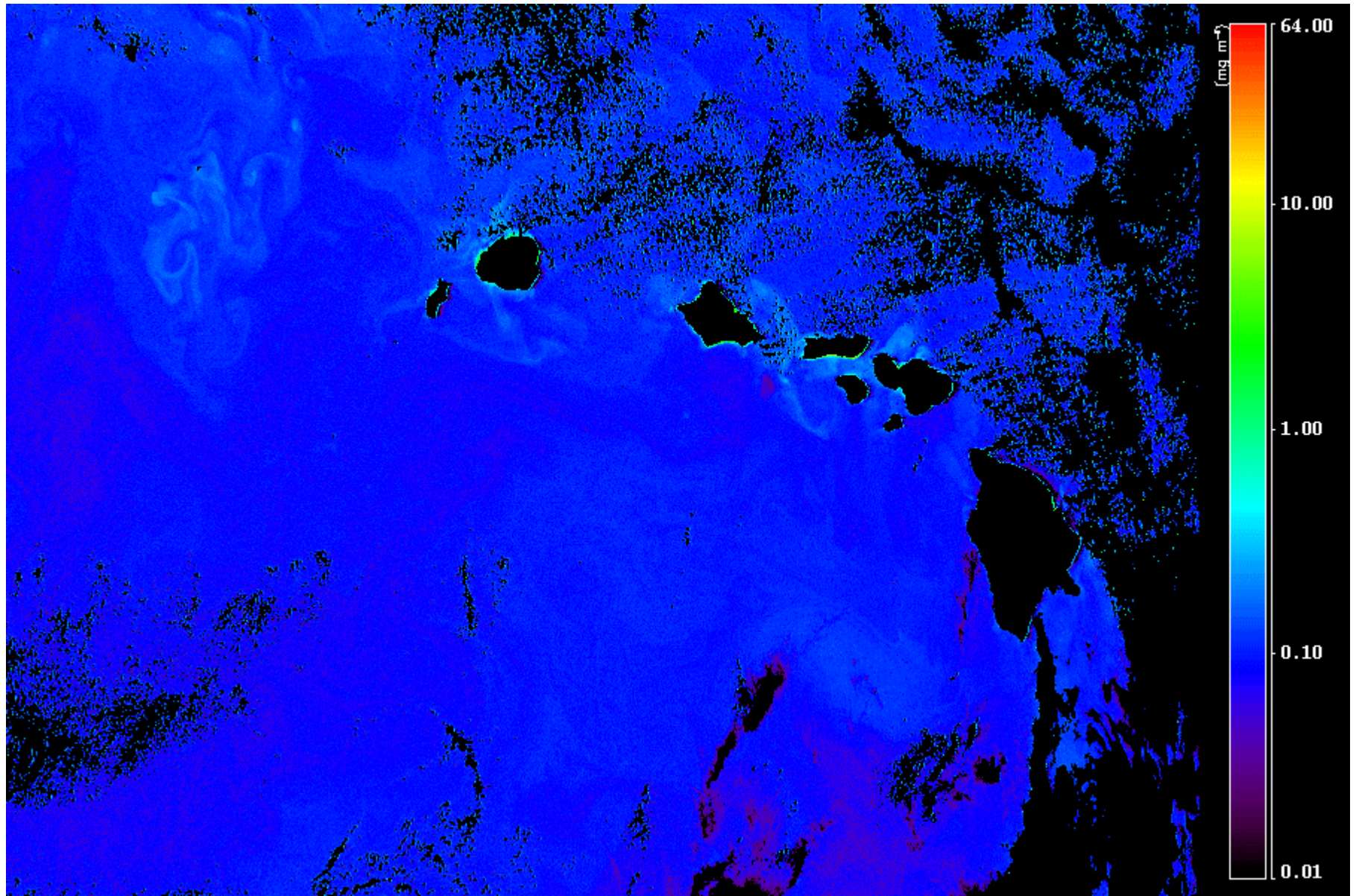
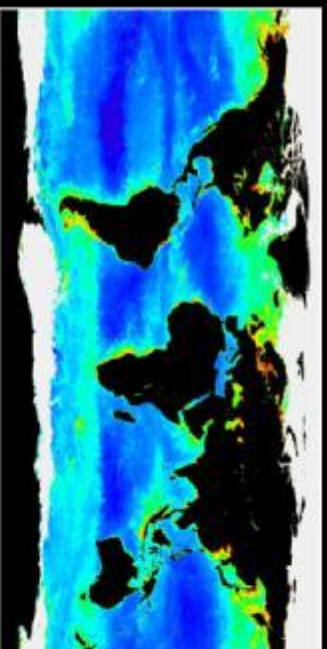# SeaWiFS "True-Color" Image Near Hawaii

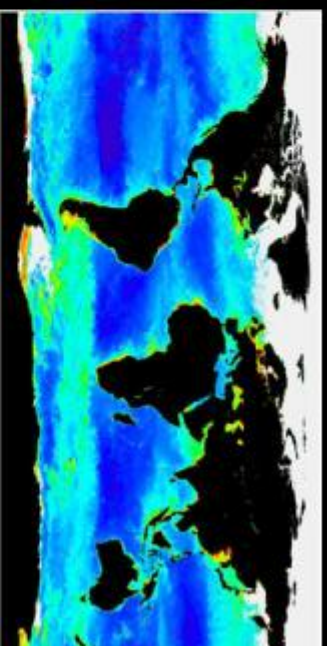# Retrieval of Lw from typical pixel near Hawaii
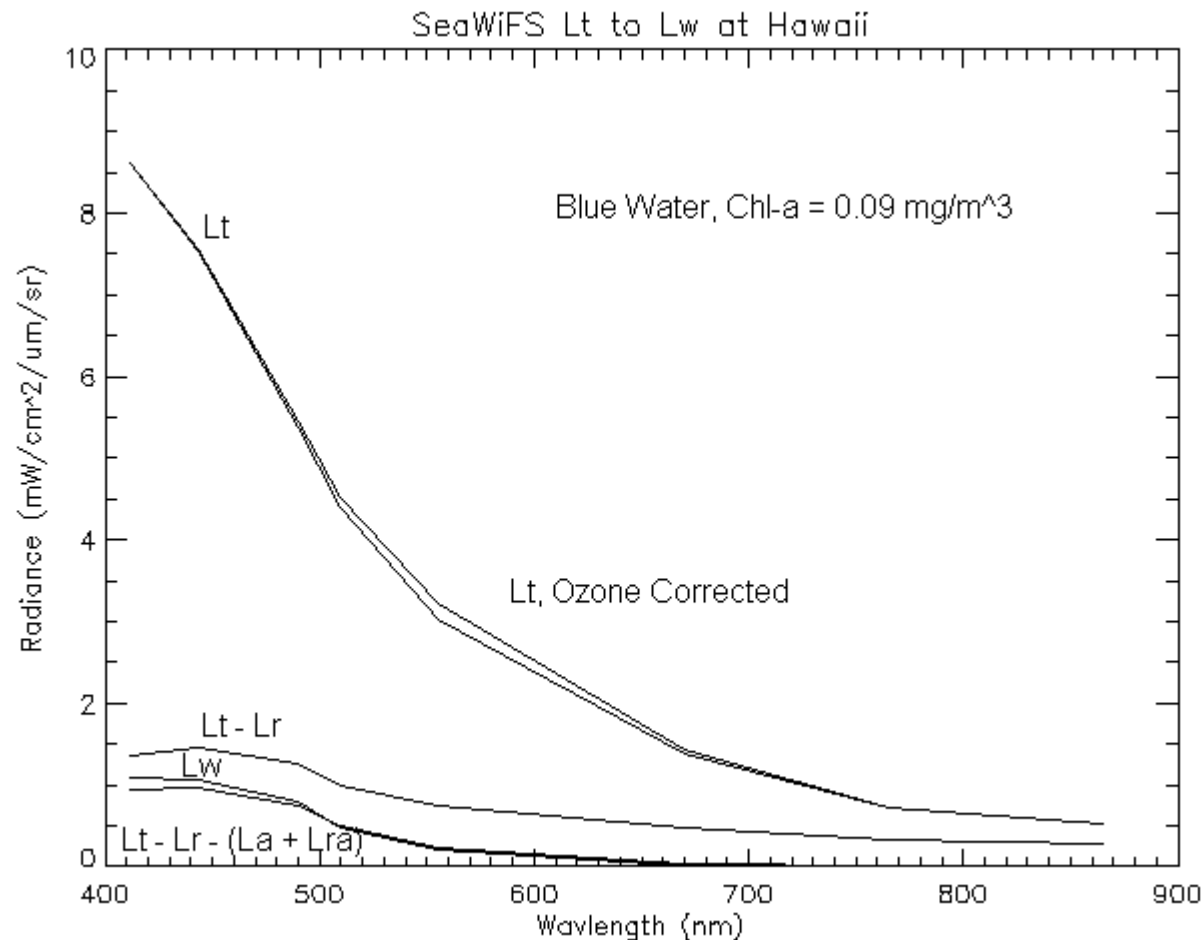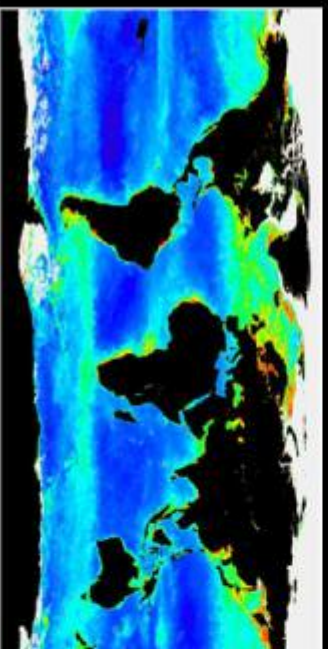
SeaWiFS Derived Chlorophyll Near Hawaii

SeaWiFS Seasonal Chlorophyll Composites

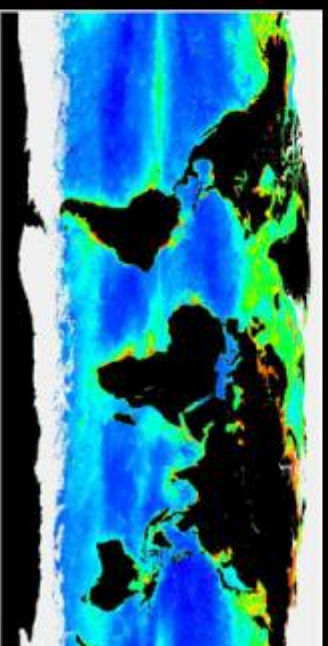

September 1997 - November 1997

December 1997 - February 1998

March 1998 - May 1998

June 1998 - August 1998

Ocean: Chlorophyll *a* Concentration (mg/m³)

The SeaWiFS Calibration and Validation Process

Pre-Flight Instrument Calibration (SBRC) → Pre-Flight Calibration (OSC)

Solar Calibration (SBRC)

SeaWiFS Launch

Pre-Flight Calibration (OSC) → Vicarious Calibration & Product Validation → MOBY Calibrations (bands 1-6)

Vicarious Calibration & Product Validation → In situ Bio-optical and Atmospheric Data Comparisons

Pre-Flight Calibration (OSC) → Time-Series Evaluations → Global 8-day Clear Water Analysis

Onboard Calibrations (time dependancy corrections) → Lunar Calibrations (monthly)

Solar Calibration (SBRC) → Solar Calibrations (daily)

SeaWiFS Lunar Observations
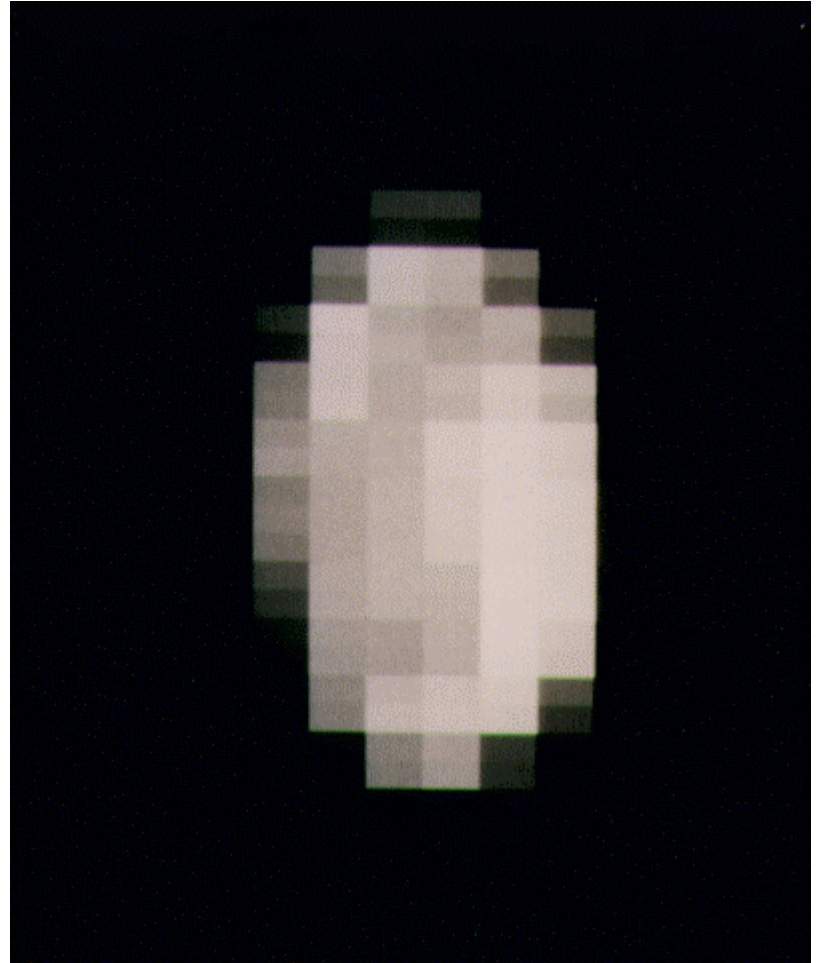
Lunar Viewing Geometry

- SeaWiFS field-of-view = 1.6 x 1.6 milliradians
- Distance to Earth = 705 km
- Distance to Moon = 384400 km
- Nadir pixel size on Earth = 705 x 0.0016 = 1.1 km
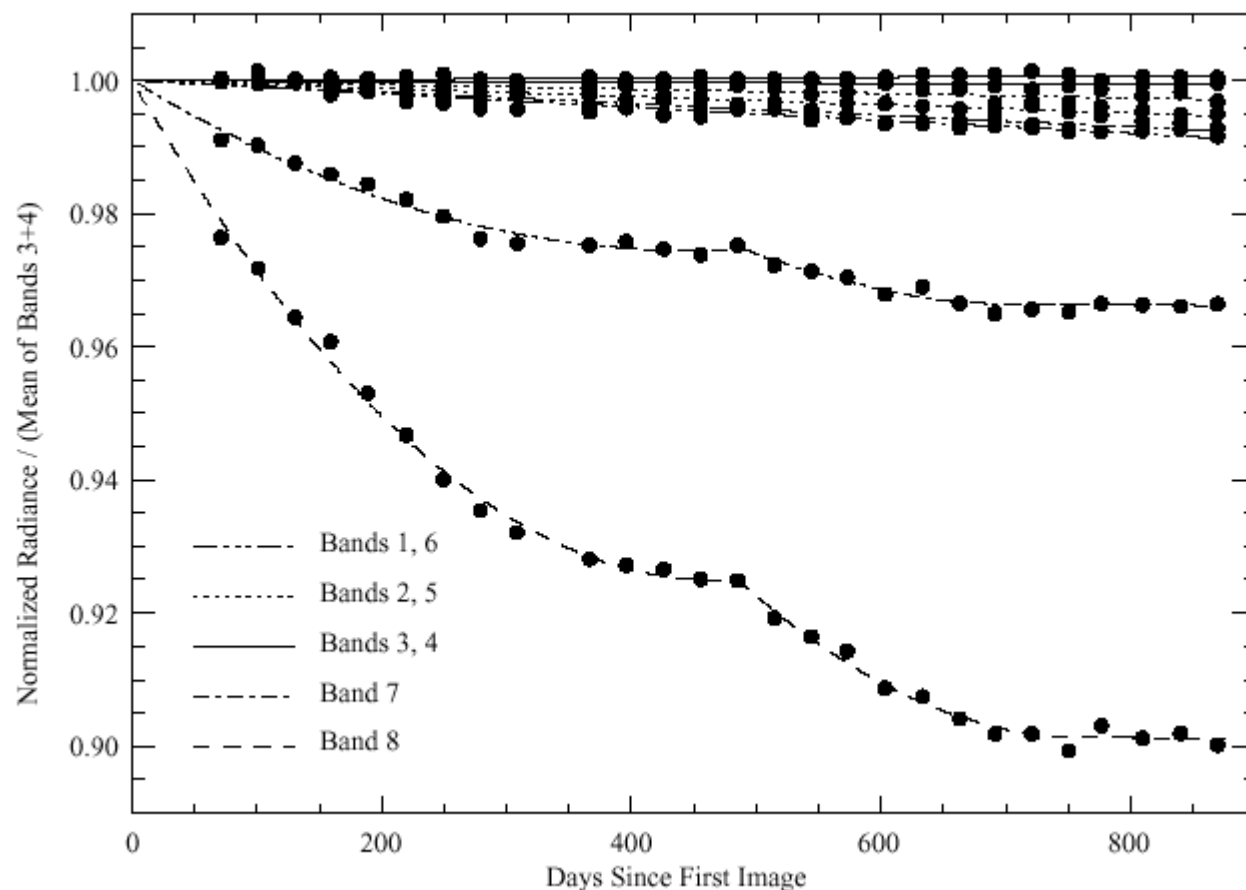- Nadir pixel size on Moon = 384400 x 0.0016 = 615 km
- Diameter of Moon = 3478 km (approximately 6 pixels)

SeaWiFS Lunar Calibration
Correction for Long-term Detector Degradation

Comparison with in situ (field) measurements

$L_{WN}(412)$

N: 144
SLOPE: 1.1078
INT: -0.0817
RSQ: 0.7329
BIAS: -0.0779
RMS: 0.2014

$L_{WN}(443)$

N: 166
SLOPE: 0.8322
INT: 0.0460
RSQ: 0.6962
BIAS: 0.0513
RMS: 0.1837

$L_{WN}(490)$

N: 173
SLOPE: 0.9394
INT: 0.0103
RSQ: 0.6303
BIAS: 0.0144
RMS: 0.1436

$L_{WN}(510)$

N: 157
SLOPE: 0.9986
INT: 0.0857
RSQ: 0.4377
BIAS: 0.0860
RMS: 0.1563

$L_{WN}(555)$

N: 174
SLOPE: 1.0660
INT: 0.0948
RSQ: 0.6320
BIAS: 0.0668
RMS: 0.1566

Chlorophyll a

N: 109
SLOPE: 0.9404
INT: 0.0189
RSQ: 0.7080
BIAS: 0.0396
RMS: 0.3014

In Situ

In Situ

SeaWiFS

SeaWiFS

SeaWiFS

Apr 14 2000